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AGRICULTURAL JOURNAL

ISSUED BY THE

DEPARTMENT OF AGRICULTURE, FIJI.

VOL. 5.] SEPTEMBER, 1932. [No. 1.

EDITORIAL.

Entomological.—This Number of the *Agricultural Journal* is largely concerned with entomological matters, among which the progress reports of the Government Entomologist on the work of the thrips introduced from Trinidad for the attempted control of Koster's Curse (*Clidemia hirta*) will prove of great interest. Investigations are still being pursued in Trinidad on other insects found by Mr. Simmonds to exercise control over the spread of the plant there, but owing to the spectacular effect of the insect already introduced, attempts to make use of the seed destroying agencies found to exist in Trinidad will be deferred until a later date and may be made in conjunction with other similar work which is being carried out for the attempted control of the weed Blue Rat Tail (*Stachytarpheta jamaicensis*).

The list of beneficial insects introduced into Fiji forms a useful and interesting record of steady entomological work extending over a long period, while the successful results which have been achieved indicate that money has been wisely spent on the various investigations involved. Since the record was compiled the giant mosquito *Megarhinus splendens* has been recovered in Taveuni where it may now be regarded as established.

Fruit Exports—Citrus.—The conclusions arrived at as a result of experimental shipments of citrus fruits sent forward to New Zealand in 1931 were put into practical effect for the 1932 season extending from March to May, during which period the following quantities were exported:—

To New Zealand.

Oranges	1,206 cases.
Mandarins	1,270 cases.
Mandarins	90 boxes.

To Canada.

Oranges	120 cases.
Mandarins	400 cases.
Mandarins	89 boxes.
	3,175

By insistence upon careful harvesting methods and proper transport conditions a high proportion of the fruit was received at the wharf packing-shed, Suva, in first-class condition, the remainder being rejected for export. The proportion of culls after the period of storage was satisfactorily low, while the neat and clean appearance of the packed cases provided ocular evidence of the improved methods of dealing with the crop. It is satisfactory to

record that markedly higher prices were realised in New Zealand, which more than paid for the additional cost of sizing, wrapping and packing.

Bananas.—The New Zealand banana market has been exceptionally poor during the greater part of this year. In January the market was over-supplied with fruit and the increasing supplies going forward from Samoa and Tonga as well as Fiji caused prices to fall and shippers to lose heavily. During the months of January and February a total of 42,800 cases of bananas were exported to New Zealand from Fiji and market prices fell to as low an average as 5s. 6d. per case for the shipment which left Suva on February 18th. The internal economic position in New Zealand contributed to a considerable extent to the conditions which occasioned a fall in prices. It was considered desirable that New Zealand markets for Fiji produce, particularly bananas, should be personally investigated and the Director of Agriculture visited the Dominion for that purpose in March. Although natural control combined with low market prices restricted the quantities going forward from Fiji from the beginning of April onwards, it still seemed desirable to enter into some arrangement which would avoid over-supply to the market, so that the possibilities of a regional supply with rationing of quantities were investigated.

The Fruit Export Ordinance was amended at the session of Legislative Council in June to empower the Governor to restrict or prohibit the quantity of bananas exported from Fiji during any specified period. Regulations were published in July imposing a quota system for supplies of Fiji bananas to the port of Auckland and a rationing scheme came into effective operation with the August shipments. It is early to indicate the results of this arrangement, but with the careful control of supplies in relation to market requirements it should be possible to secure a payable return to the producer without imposing a burden on the consumer.

Copra.—The London market price for South Seas copra advanced during February and early March but has since declined, being now fairly steady at just under £14 a ton. The position from the producer's point of view, however, is much more hopeful as crop prospects are good and under normal conditions the 1933 out-put should closely approach the average for the five year period 1925–29 which was 28,347 tons.

The inclined chamber copra drier erected at Vuna, Taveuni, was ready for operation in March and since then has been in continuous service. For the earlier part of the period it was not working to full capacity owing to shortage of trays occasioned by a mistake on the part of the erectors. This has now been remedied and the drier is capable of taking a charge of 45,000 lb green copra per 24 hours. The drying is efficiently performed and fuel consumption is satisfactorily low, though further heating economy may be attained by additional insulation of the drying chamber, a point which is now under experimental investigation. The drier will afford a much needed opportunity for experimental inquiry and it already gives promise of yielding valuable information. The Fijians in whose district it has been erected fully appreciate of its usefulness.

Exhibitions.—The Department has co-operated with the Fiji Publicity Board in arranging for the collection, preparation and transmission of exhibits for the Auckland Winter Exhibition held in July and the Central Canada Exhibition, Ottawa, in August. The latter exhibition included an Empire Section in which Fiji had a stand. It was opened immediately after the conclusion of the Ottawa Conference and from early reports was an undoubted success. Mr. G. K. Roth, District Commissioner, who was

proceeding on leave *via* Canada very kindly undertook to act as representative of the Colony at the Exhibition. He has concluded arrangements for the transfer of the whole exhibit to Montreal where it will be staged at a special Colonial Exhibition organised by James A. Ogilvie Ltd. Tentative inquiries have been received regarding the possibility of staging the Fiji exhibit at Winnipeg during October, but at the time of going to press final arrangements have not been made. Among the agricultural exhibits sent were specimens of banana figs prepared by the Government Chemist in connection with which an article appears in this issue.

Mr. Anson, Cotton Specialist, undertook the supervision of the exhibit at the Auckland Winter Exhibition. He received several inquiries for Fiji produce which should lead to increased business between Fiji and the Dominion while incidentally helping forward the marketing of crops from the Fiji agricultural instructional centres which are under Mr. Anson's care.

ENTOMOLOGICAL NOTES.

COCONUT PESTS.

1. *T. trichogramma*.—Larvæ of this coconut pest were found during 1931 in the flowers of the native fan palm (*Pritchardia pacifica*) and the royal palm (*Oreodoxa regia*). Apart from these palms, *T. trichogramma* is known at present to feed only on the coconut palm. (R.W.P.)

2. *P. reichei*.—All stages of this coconut pest were seen in December at Lomaloma on two species of fan palm growing near the court-house—one species is *Pritchardia pacifica*; the other is a close relative with longer flower stems. (R.W.P.)

3. *Tirathaba rufivena* is a pyralid moth distributed from Ceylon to New Caledonia, being found on that island by Paine in February, 1931. Its only known host-plants are given as the coconut, banana and French bean (*Phaseolus vulgaris*). While examining the inflorescence of the swamp palm (*Nipa fruticans*) in October, 1931, on Guadalcanal, British Solomons, the author found the larvæ and pupæ of this moth, the former being parasitised by an apparently new species of *Apanteles*, not unlike *A. tirathabæ* introduced from Java into Fiji. (R.J.A.W.L.)

4. Another pest of coconuts in the Solomons is the Hispid beetle *Brontispa froggatti*, related to the Fijian *Promecotheca reichei* which has not been found elsewhere than on *Cocos nucifera*. In the same island of Guadalcanal, the author has found the eggs, larvæ, pupæ and adults on the leaves of a wild palm, *Ptychosperma sp.* (R.J.A.W.L.)

FRUIT-FLY TRAPPING.

5. The Queensland Government Entomologist, Mr. Hubert Jarvis, recently evolved a lure which proved very attractive to several species of Queensland fruit-flies, including those belonging to the genus *Dacus*, to which genus belongs the common Fijian species, *Dacus passifloræ*. In view of this, it was thought possible that the bait might prove equally attractive to the Fijian species, and small experimental trials were made at Nasinu.

Encouraging results were obtained and it was decided to set out six of these traps in the citrus patch. The yields from these traps have been most

remarkable. The percentage of females, many of which were just ready to oviposit, has averaged more than twelve times the number of males. The following are the catches representing four weeks' trapping:—

Date.	*No. days.*	*Females.*	*Males.*
10/3/23	6	187	18
17/3/32	7	165	14
30/3/32	13	227	15
	..	579	47

The traps used are the common glass fly-traps which are normally placed upon tables. These are swung by stiff wire from branches of trees in the neighbourhood of the fruit which it is desired to protect. They are obtainable wholesale from the Australian Glass Company of Sydney at 1s. 3½d. each, and are retailed in Sydney at about 1s. 9d. The bait consists of the following formula:—Scrubb's ammonia, 1 table-spoon; Essence of Vanilla, 1 tea-spoon; water, 1½ pints.

In addition to the above experimental trapping, a solitary one was set in the writer's own garden in Suva. This yielded a small number of females only—about ten—but is interesting as having captured examples of two other fruit flies, one of which may prove to be a recent introduction or a new species,* as it has not yet been captured outside Suva.

If commercial orchards are established in Fiji, the results of the above trials indicate that trapping is likely to prove most helpful in keeping these orchards free from fruit-fly attacks, whilst the cost is so low that it should justify gardeners and small growers in attempting to protect their crops from this pest. (H.W.S.)

THE SILVER FISH AS A HOUSEHOLD PEST.

6. The following information is summarised from *Farmers' Bulletin* No. 1665, published by the United States Department of Agriculture in June, 1931, to which reference can be made if desired.

The silver fish (*Lepisma saccharina*, L.) is that glistening silver or pearly grey insect with three long tail-like appendages that is often seen when books papers, clothing or similar articles are suddenly moved. It is one of the most serious pests of libraries, being particularly destructive to the binding of books. In this case it is the starch paste which it is after and it also does much damage to starched clothing, &c., or to the paste fastening wall-paper. The insect is slow in development and long lived, being able to go without food for almost a year.

Remedies.—They are easily poisoned by using a mixture of 12 parts of sodium flouride powder to 100 parts of wheat flour or by making a paste of ½–¾ oz. white arsenic to one pint wheat flour and adding enough water to make a thin paste by boiling. This should be poured on small pieces of stiff paper which later can be rolled into cylinders with the paste inside. The powder or paste should be put in out of the way places frequented by the insects. Both are poisonous, the second highly so. Pyrethrum powder dusted in their haunts is of value, but requires frequent renewal.

Where the insects are in hordes, a saturated solution of paradichlorobenzine in carbon tetrachloride used as a spray is useful, particularly if the

* Since identified by the British Museum as *Dacus xanthodes*, Brown, an old, but apparently scarce, inhabitant of this country.

room can be closed for twenty-four hours. In addition to the above remedies, it is recommended to handle frequently and air starched clothing, destroying any of the insects found present. (H.W.S.)

TERMITES (WHITE ANTS).

7. Attention has been recently directed to a case of serious damage to a building in Suva by white ants. The building was an old wooden one, in the business portion of the town, and the damage was very extensive. Unfortunately when the Entomologist was informed the damaged timber had already been removed and destroyed, and he was told that the termitarium had been located and burnt.

The termitarium was placed between two posts 6 in. by 6 in., which had been destroyed, and was 6 ft. high by about 2 ft. by 6 in. As everything had been destroyed it was not possible to have the species causing the damage identified.

Termites occur in the Fijian jungle, but this is the first time that the attention of the Department has been called to severe damage of this nature to city buildings and it is possible that the insect may prove to be a foreign introduction.

The Director of Agriculture would be grateful, if, when damage to buildings by these insects is observed, specimens of the termite causing the damage may be handed to the Government Entomologist, in order that it may be possible to ascertain what species are doing damage. (H.W.S.)

A LIST OF INSECTS INTRODUCED INTO FIJI FOR THE BIOLOGICAL CONTROL OF PESTS AND WEEDS.

Compiled by H. W. SIMMONDS, F.E.S., Government Entomologist.

THE writer has attempted to compile a list of those insects which have been deliberately introduced into Fiji in the attempt to bring certain insect pests and noxious weeds under control by biological methods. The assistance rendered to the writer by Mr. R. W. Paine is gratefully acknowledged.

It will be observed that 45 different species are recorded as having been introduced, either by the officers of the Agricultural Department or the Colonial Sugar Refining Company Limited, and that of these 18 are known to have established themselves. Some of these introductions have proved extremely successful, attaining a high measure of the desired control. In this respect special mention should be made of:—

Ceromasia sphenophori against cane-borer in the wet zone only.

Plæsius javanus against banana-borer in certain portions of the Rewa.

Ptychomyia remota against the purple coconut moth throughout its range.

Cryptognatha nodiceps against coconut scale throughout its range.

Liothrips urichi against the weed *Clidemia hirta*.

In compiling the list the country whence the insects were obtained is mentioned in addition to the country of origin, where known. This seems a suitable place to acknowledge the courtesy of the Hawaiian Sugar Planters' Association and the Department of Agriculture, Hawaii, through whose assistance all the species introduced from that Group have been obtained.

PRELIMINARY LIST OF INTRODUCTIONS INTO FIJI (INCOMPLETE).

Insect.	Introduced from.	Native of.	Introduced by	Against.	If known to be established.	Remarks.
**Ceromasia sphenophori*, Vill.	New Guinea	New Guinea	F. Muir	*Rhabdocnemus obscura* Bois.	Yes	
Do.	Hawaii, 1912	Do.	D. S. North	Do.	Well established	
Do.	Hawaii, 1913	Do.	Professor Illingworth	Do.	Rewa and Labasa	
**Scolia manilæ*, Ashn.	Hawaii, 1914	Philippines	R. Veitch	*Rhopæa vestita, R. subnitida, Adoretus versutus.*	Established Lautoka	
**Plæsius javanus*, Er.	Java, 1914, & successive shipment.	Java	F. P. Jepson	*Cosmopolites sordidus*	Established Vitilevu	
**Agromyza lantanæ*, Frogg.	Hawaii, 1910.	Mexico	F. P. Jepson	*Lantana crocea, L. camara.*	Established everywhere.	
Thecla echion, Linn.	Hawaii, 1923.	Mexico	H. W. Simmonds.	Do.		About 65 liberated.
**T. agra*, Hew	Do.	Do.	Do.	Do.	Established Vitilevu and Ovalau.	
**Teleonemia lantanæ*, Dist.	Hawaii, 1928.	Do.	Do.	Do.	Well established everywhere.	Succesful for a short time then came under local predatory control.
**Ptychomyia remota*, Ald.	Kuala Lum pur, 1925	F.M.S.	H. W. Simmonds & T. H. C. Taylor	*Levuana iridescens*	Established Vitilevu, Ovalau and Beqa.	Highly successful throughout range of host.
Callimerus arcufer, Chap.	Do.	Do.	Do.			

**Trichogrammatoidea nana*, Zehut	Java, 1927	Java	T. H. C. Taylor	*Lcvuana iridescens*	Established through out group 1929†	Only 25 liberated Makaluva 1927, possibly already in country.
Chalcid sp ? (chalcid B)	Java, 1927	Java	T. H. C. Taylor	*Levuana iridescens*		
**Liothrips urichi*, Karny.	Trinidad, 1930.	Trinidad	H. W. Simmonds.	*Clidemia hirta*	Well established Vitilevu, Taveuni, Vanualevu & Ovalau.	Highly successful everywhere.
**Aspidiotiphagus citrinus*, Craw.	Tahiti, 1920 and 1921.		H. W. Simmonds.	*Aspidiotus destructor*	Established	
**Aphelinus chrysomphali*, Mercet.	Do.		Do.	Do.	Do.	
**Scymnus*, sp.	Java, 1927	Java	T. H. C. Taylor	Do.	Do.	
Spaniopterus crucifier, Gahen, (chalcid).	Do.	Do.	Do.	Do.		
Comperiella unifasciata, Iskii.	Do.	Do.	Do.	Do.		
Casca parvipennis, Gahen.	Do.	Do.	Do.	Do.		
Thrips	Do.	Do.	Do.	Do.		
**Cryptognatha nodiceps*, Morl.	Trinidad, 1928.	Trinidad,	Do.	Do.	Established Vitilevu Vanualevu, Taveuni and Ovalau.	Generally highly successful.
Cryptognatha similima, Sic.	Do.	Do.	Do.	Do.		
Azya trinitatis, Morl.	Do.	Do.	Do.	Do.		
Pentilia insidiosa, Muls.	Do.	Do.	Do.	Do.		
Azya luteipes, Muls.	Hawaii, 1928.	Mexico	H. W. Simmonds.	*Lecanium*, sp.		Only 6 liberated.

PRELIMINARY LIST OF INTRODUCTIONS INTO FIJI (INCOMPLETE)—*continued.*

Insect.	Introduced from.	Native of.	Introduc by.	Against.	If known to be established.	Remarks.
Orcus australasiæ, Boisd.	Australia, 1924.	Australia	A. M. Lea	*Diaspinæ*		Being a consignment of general beneficial insects brought in by A. M. Lea.
O. chalybeus, Boisd	Do.	Do.	Do.	Do.		
Leis conformis, Boisd	Do.	Do.	Do.	Aphids		
**Cryptolæmus montrouzieri*, Muls.	Do.	Do.	Do.	Mealy bugs	Established Vitilevu	
Chrysopa ramburi	Do.	Do.	Do.	General feeder on small insects.		
Microbracon omiodivorum, Terry.	Hawaii, 1928.	Japan	H. W. Simmonds.	*Nacoleia octosema*		Only 100 liberated.
Do.	Hawaii, 1925.	Do.	R. W. Paine and T. H. C. Taylor.	General	Being a consignment of general beneficial species and brought in by Messrs. Paine and Taylor.	Do.
Trichogramma pretiosa, Ril.	Hawaii, 1925.	North America.	Do.	Do.		Do.
Chalcis obscurata, Walk.	Do.	Japan	Do.	Do.		Do.
Echteromorpha maculipennis.	Do.	?	Do.	Do.		Only 12 liberated.
Frontina archippivora	Do.	North America.	Do.	Army worm		
Casarina infesta, Cress.	Do.	U.S.A.	Do.	General		Only 24 liberated.
Chelonus blackburni	Do.	Hawaii	Do.	Do.		Only 12 liberated.
**Euplectrus platyhypenæ*, How.	Do. Do.	Mexico Do.	Do. R. Veitch	Do. Do.		Probably already present from Veitch's introduction.

**Apanteles tirathabæ*	Java, 1930	Java	T. H. C. Taylor	*Tirathaba trichogramma.*	Established Vitilevu and Vanualevu.	
Erycia basifulva, Bezzi.	Java, 1931	Java	R. W. Paine	Do.		
**Teleonomus*, sp.	Do.	Do.	Do.	Do.	Do.	
**Megarhinus splendens*	Do.	Do.	Do.	*Aedes variegatus*	Bred Suva & Taveuni	Well established at Savusavu and Taveuni.
Spalangia cameroni	Hawaii, 1928.	?	H. W. Simmonds.	House-flies		
Mesembrina meridiana, L.	England	England	H. W. Simmonds.	House-flies		
**Copris incertus*, var. *prociduus.*	Hawaii, 1928.	Mexico	Do.	Do.	Established Suva district.	

Those species known to be established are denoted by a *. † The identification of this not yet confirmed. It may prove a different sub-species, or may have been here prior to liberation on Makaluva; it could hardly have spread in two years to Lau and all over the Group.

In addition, it is probable that *Spalangia muscidarum*, Rich, was also introduced. It was not uncommon in and about the Suva stables a few years ago. *Spalangia cameroni* has also probably made good, but the identification is not yet certain. They may be synonyms.

REPORT ON BANANA BORER (COSMOPOLITES SORDIDUS).

By H. W. Simmonds, F.E.S., Government Entomologist.

INVESTIGATIONS, APRIL, 1931—APRIL, 1932.

EARLY WORK.

Before proceeding to describe the work of the past year, a summary of previous work done on the pest in Fiji should prove of value.

The earliest records of the beetle in Fiji date to 1906. By 1909 it was widely distributed, causing much alarm. In view of its ravages it was decided to attempt to control it biologically and, in 1913, F. P. Jepson (Government Entomologist) imported and successfully established the predatory beetle *Plæsius javanus*. The value of the measure of control thus obtained was, however, limited and very slow in showing up. Efforts were also made to establish this beetle in Queensland, Hawaii and Jamaica, but with only minor success. Many experiments have been made to reduce the numbers of the pest by chemical methods such as corrosive sublimate and other dips, and soil fumigants such as paradichlorobenzene, but none of these have achieved any real measure of success. Froggatt devised a method of removing a section of corm, dusting it with Paris green and replacing it, which was probably the most efficient of the chemical methods.

Early trapping in Fiji.—In 1921 there was, at Nasinu, a plot of bananas absolutely rotten with borer and an attempt was made to reduce their numbers by trapping. In nineteen weeks, no fewer than 16,205 adults were captured with no indication of reduction in the numbers present. The experiment was abandoned owing to the closing of the station.

Flight experiments.—With the closing of Nasinu in 1922, the Department had no land for further experimental work until 1927-8, when arrangements were made to use a portion of Calway's nursery at Lami to test what part flight played in the spread of the pest (*Agricultural Journal*, Fiji, Vol. 1, No. 3, pages 22-27).

For this purpose, thirty clean suckers grown from eyes were planted with a protecting circle of galvanized iron six feet in diameter, a similar set of thirty suckers being interplanted as checks. The area was an abandoned banana block, badly infected with borer and it was felt that if flight was frequent, the protected plants would, in twelve months, become infected.

The result, at the end of the year's growth, was that none of the protected plants were found to have become infected and, more surprising, only a small percentage of the check plants had been attacked. The above, and certain laboratory tests seemed to indicate that flight and migration were only minor factors in the spread of the pest and that normally infection took place with the suckers used to plant up estates.

The new set of experiments carried out this year show that this conclusion was wrong, but at the time they were considered so encouraging that it was

felt, that if clean suckers were used and clean land planted up, migration would be of so little importance that the crop would be gathered before material harm was done.

Clean suckers.—Until recently, many parts of the world were able to obtain clean planting material from unaffected areas and by using these and cleaning up old blocks, were able to hold the pest in some check. The universal distribution of the pest in Fiji rendered this impossible and growers had to face losses up to 60 per cent., due to diseased planting material.

Attention in 1929-30 was therefore directed towards some method of treatment that would ensure suckers being clean, despite the presence of the pest in the plant from which they were taken. In devising such means, it was important that, if possible, the method should be one which could be applied by anybody, anywhere, and, at a nominal cost.

Such a process was evolved by a method of partial immersion in fresh water for a period of twenty-one days (*Agricultural Journal*, Vol. 4, No. 2, pages 63-64). Many other ideas were tested, such as sulphuric acid, formaldehyde, corrosive sublimate, and oil of chenapodium dips, all of which gave a measure of protection but failed to reach the larvæ in the interior of the corm.

More encouraging results were obtained by means of a vacuum fumigator, using carbon-di-sulphide, but even this fell short of the 100 per cent. kill that was required and the method would be quite impracticable in out of the way districts. Several methods which suggested themselves such as controlled heat were abandoned for the same reason or on account of cost, the more so that the cold water immersion method is simple, practicable anywhere, cheap, and possesses only the trifling disadvantage of taking three weeks. Experiments now to be detailed were based on this method of obtaining a primary clean start.

EXPERIMENTS, 1931—1932.

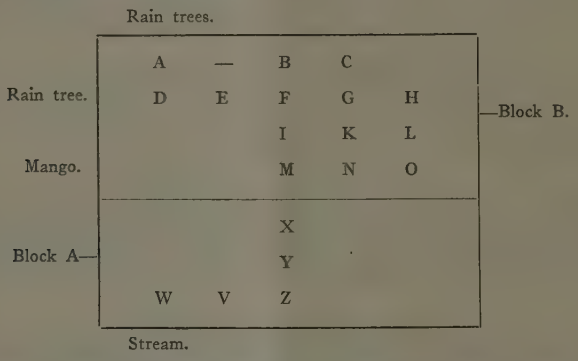
Early in 1931 the Entomologist took over a piece of land adjoining his own garden and decided to make use of the opportunity of having an area under his own daily personal observation to utilise a portion of it as a banana borer experimental plot.

Situation.—The area is a steep gully, with rather shallow black soil, overlying soapstone, which latter outcrops in places. There is a stream at the bottom of the gully and the soil is much deeper as the banks are approached.

Objective.—When the experiment was commenced, it was thought that migration was slow and the objective was to show that by using treated borer-free suckers, such suckers would give a better plant and bigger yield than ordinary selected commercial plants. With this objective the check plants were given the advantage of the deeper soil at the base of the gully and a further (unintentional) advantage of some four or five weeks wet summer weather in which to become established before the treated plants were put in.

The plots.—(A) These were the check plants, consisting of eight good hand-cleaned suckers. They were planted at the beginning of March but, despite every care, three had to be removed owing to heavy borer attacks. The remaining five were labelled V–W–X–Y–Z.

(B) Consisted of fifteen good commercial suckers which were subjected to 21 days soaking and planted out on the hillside on April 9th, 1931. In preparing the land, it was found to be a network of roots from some adjoining rain trees and, where possible, these were cut through. One of these treated suckers developed bunchy top and was at once destroyed. The balance died back, and grew from eyes, being labelled A—O. The two blocks then stood as follows:—



Discovery of borer.—As mentioned above, three suckers in Plot A failed to grow and were destroyed owing to the presence of borers. There is every reason to suppose that Plot B (the treated plot) remained clean until some time in October. Heavy floods occurred on the 20th of that month and on the 24th, when showing a planter over the block, the latter pointed out a case of incipient bunchy top on a sucker of plant K. When the affected sucker was removed, four adult borers were found upon it. This discovery was most disconcerting showing either—

(1) inefficiency of the soaking treatment; or

(2) unexpected powers of migration on the part of the borer.

There is no question that the second was the explanation. This discovery demonstrated that if the borer was to be controlled, the mere use of borer-free planting material was insufficient and that further control methods would have to be adopted.

Partial change of objective of experiment.—It was therefore decided to commence trapping, using sections of stem or corm and collecting daily by hand, in order to see —

(1) whether starting with clean plants these methods would keep the plants reasonably clean;

(2) whether trapping gave sufficiently increased yield to warrant the cost;

(3) general effect of borer control upon the plants.

A record was kept of the numbers of borers obtained from each plant and a graph also prepared for each. From February 20th onwards, the sexes also were recorded. This necessitated dissecting each beetle as they show no external sexual differences.

The following table shows the numbers of beetles trapped from Plot B during the period under review. A few beetles were also taken from Plot A, but this was stopped in order to retain them purely as check plants:—

RECORD OF PLOT B.

	Oct., 24–31.	Nov., 1–30.	Dec., 1–31.	Jan., 1–31.	Feb., 1–29.	March, 1–31.	April, 1–9.
A	..	..	1	..	..	..	..
B	..	..	..	..	..	..	1
C	..	1	..	7	8	..	..
D	..	3	1	..	5	2	3
E	..	2	2	2	3	3	3
F	1	1	3	6	6	4	5
G	1	2	2	1	1	1	4
H	..	3	4	2	9	..	3
I	2	1	34	11	3	2	..
K	5	2	13	9	5	2	..
L	..	2	4	1	4	..	..
M	4	4	5	2	2	..	4
N	..	..	..	7	6	5	1
O	7	10	32	10	7	5	5
Tl.	20	31	101	58	59	24	29

Graph.—A copy of the graph will be inserted at the end of this report. A study of this shows that no breeding has probably taken place in stools A, B, D, E, G and H, the limited numbers captured being migrants. The remainder all give indications of having, at some time, had a resident breeding population. To what extent this is so is, however, most uncertain until the plants are dug out. This is written advisedly because stool K, which had thrown two bunchy suckers and yielded 36 adult borers, was dug out on April 21st, 1932. It was then found that despite every appearance from the graph of a resident breeding population, the stool was completely clean and free from old larval tunnels. This was a most astounding discovery, indicating that the whole 36 adults were migrants and demonstrating dispersal by this method far beyond anything thought possible.

Migration.—The question then arises as to how this migration takes place. Two methods are possible—(*a*) crawling, (*b*) flight.

Crawling.—The area is protected at the bottom by a stream, on one side by a paddock of high guinea grass, and on the top by a road and general absence of bananas, whilst on the south-west it has a large area of garden, so that the only plants from which crawling could be expected to take place would be the five check plants at the base of the area. The numbers do not point to such an origin, so that one is forced to look to the second possibility as the origin of the invasion. This is supported also by the incidence of the captures which are generally lightest in those stools which are protected by tall trees and the crest of the hill.

Flight.—For many years it was supposed that the adult beetle did not fly, but on several occasions in Fiji, and also in Queensland, adults have been obtained under circumstances which seemed to indicate that they had recently made use of such method of locomotion. The first definite record of flight was made by Urich in Trinidad, who captured an adult flying strongly against the wind in wet weather and a mile from any banana plants. Corroborative records have been obtained in Queensland where, in muggy

summer weather, several specimens have been recorded as having flown into houses. These records have not, however, been actually made by entomologists.

In Fiji the first definite record was obtained in November, 1931, when, as the Entomologist switched on the light, a specimen flew into a room and fell into a basin, its wings still expanded. It entered against the wind and in the direction of ripe banana fruit on the table.

There is, therefore, no doubt as to the ability of the beetle to fly, the only question being as to what extent this ability is utilised. The experiments carried out in 1929 at Lami indicated that it was seldom availed of, whilst laboratory experiments in which borers isolated from food by water made no attempt to cross that water by flight or even under the influence of heat, all pointed in the same direction.

The incidence of the present captures, however, strongly points to flight as a factor, probably the main factor in the spread of the pest, such flight having been normally against the prevailing wind.

Causes of migration.—Efforts to co-relate the numbers of adults found under the traps with the published meteorological observations have proved inconclusive, beyond the general fact that in cool weather migration ceases. Contrary to statements made regarding Queensland, there does, however, seem to be a definite movement of the adults in periods of heavy rain.

No evidence has been obtained to suggest that flight is an essential to mating, but on the contrary, mating seems to take place on the old cut surfaces amongst the resident population. Those few cases where two adults have been taken under one trap and which, by the absence of further captures, indicate that both are migrants have proved to be male and female and, so far as the small amount of evidence goes, it points to the female being the primary migrant and to the male being attracted by the presence of the female rather than to the plant.

Sex ratios of trapped beetles.—Externally the sexes of adult borers are alike so that in every case dissection is necessary in order to ascertain sex. It was of course necessary to find out if females were being freely attracted to the baits and for this purpose one hundred adults, taken at random from the traps in Plot B and from material similarly obtained at Navuso were examined. These gave 54 males and 46 females, of which 25 contained ova. The ovary was found to consist of two paired ovarioles, so that eggs would be deposited normally in fours and it was not unusual to find a female with eight ova nearly ready to deposit. The large proportion of captures of fours would indicate that they represented entire broods. This seemed a most unlikely event and the discovery that Plant K, despite several such groupings in the adults trapped at its base, was clean, negatives the idea.

The more recent daily dissection of isolated captures gave a high percentage of females, generally immature, indicating as mentioned above, the possibility that the immature female is the primary migrant and that the males follow.

Observations made on the butts of plants after the removal of the bunch in Block A and elsewhere indicate that when a female has taken up her residence in a corm she remains there a considerable time, perhaps permanently, forming with her attendant males a resident population and that the migrating females are normally young ones which have not commenced ovipositing.

Economic value of banana borer control.—In the experiment under review two sets of plants have been grown:—

A—consisting of eight good suckers, planted on deep black soil with some four weeks' initial wet season advantage over B. Of these, three failed to grow on account of borer, whilst the remaining ones produced only poor to medium eight-hand bunches;

B—consisting of fifteen good suckers, treated by the immersion process, on similar but shallow soil on the hillside above A, being hardly established when the dry season set in. They also had the additional disadvantage of a network of rain tree roots throughout the area. One of these plants had to be destroyed owing to bunchy top, a second (and probably a third) having to be removed a year later for the same reason. This plot has yielded an average of 9·15 hands per bunch and will in several cases throw its second bunches before any of the plants on the check area A do so. In addition, none of the B section has been seriously damaged by the beetle as compared to 37·5 per cent. destroyed by this agency in A.

The above shows a definite gain of 37 per cent. more plants and of 1·15 hands per bunch in the first bunch in the treated and trapped area over the check and this despite the very much more adverse conditions against which the treated plants had to contend compared with the check plants.

The full value of the control should, however, not become manifest until the ratoons develop and, whilst the indications are that these will be not only better but earlier, it is felt that eventually the soil, which is shallow where the treated plants are growing, will become worked out and thus offset the value of the borer control.

In order to overcome this, a larger area has now been established, under strict experimental conditions, at Nasinu, where the results obtained in this area will be checked and enlarged.

Bunches.—Bunches were shot as follows

Untreated area A.—All shot their bunches in November, 1931, all being eight hands.

Treated area B.—In these the shooting was much more uneven, possibly owing to the lateness of the season when planted and plant L has not yet produced its fruit. The following are the approximate dates of shooting, number of hands and number of borers trapped during the period:—

Stool.	Date.	No. of hands.	No. of borers.
G	26/12/31	8*	9
C	30/12/31	9	16
F	31/12/31	8	22
N	24/1/32	10	20†
K	28/1/32	10	37†
E	30/1/32	9	12
O	3/2/32	8	73
H	17/2/32	10	18
D	20/2/32	9	11
I	21/2/32	9	53
M	15/3/32	9	18
B	22/3/32	10	2
A	24/3/32	10	1
L	——	—	18

K was dug out and replanted on 21/4/32.

N will be dug out and replanted.

* Small. † Showing bunchy and much leaf spot.

It will be seen that there is no close co-relation between the numbers of borers trapped and the size of the bunch produced in the above. There is, however, likely to be some closer co-relation as time goes on, when the effects of the attacks in retarding development begin to show up.

Leaf spot.—Some remarks on this disease may be of use to future workers. The condition was present throughout the area but did not spread. Plant Z in the check area showed it badly, developing its bunch very slowly. The bunch was shot between November 10th and 22nd, and was not cut until April 15th, taking twice the normal period to develop. It showed no sign of discoloration on breaking a fruit nor did it ripen prematurely.

Of more suggestive value perhaps, is the case of Plants K and N. Plant K undoubtedly had the virus of bunchy top, throwing an occasional bunchy sucker and this and Plant N were the only two showing any amount of leaf spot. Plant N also showed symptoms of bunchy top in the main stem.

The statement has been made that trees growing in partial shade do not develop the disease. Plants A, B, C and D, all partially shaded, were particularly clean, as also was a plant at Nasinu growing right under a bush tree.

So far as the evidence of this small block is concerned, it inclines towards leaf spot being a secondary condition following on weakening of the plant by borer, bunchy top virus, or other unfavourable condition such as water logging. This may be the reason that the so-called Sigatoka disease (or Leaf Spot) flashed up so suddenly in 1913 at the time that the borer had reached its maximum.

Note, 4/5/32.—Plants K, N and H have all now been dug out. They had yielded 36, 21 and 21 borers respectively at their traps to that date. On examination none was found to have had borers in its roots. K and N both had shown bunchy symptoms and considerable leaf spot. When cut, the bunch of K showed no sign of premature ripening. Bunch N was not cut until the 30th so that as this is written only four days later, it is too early for a definite statement, but so far it is showing no symptoms whatever, and both K and N are bunches which planters had stated would not carry.

FURTHER NOTES ON BANANA EXPERIMENT.

During the time that has elapsed since the above was written, before it could be typed, a few additional facts have been noted.

Plants K and N which had considerable leaf spot and also incipient bunchy top, but no internal borer, have had their bunches cut. K took 16 days before the first was ripe enough to eat, ripening normally. N took 17 days and also ripened normally.

CONCLUSION.

(1) The experiment has shown that the banana borer *Cosmopolites sordidus* is capable of very rapid migration.

(2) That the soaking method is highly efficient in producing clean suckers from infected stock.

(3) That trapping, when the plants are clean is efficient in maintaining them reasonably clean.

It also indicates but does not prove:—

(1) That flight is the main factor in the spread of the pest.

(2) That the presence of one beetle at a stool is the main attraction for others, particularly males coming to that stool.

(3) That once a female has commenced to oviposit in a stool a resident non-migrating population accumulates.

(4) That in most cases the traps intercept the migratory population before it commences ovipositing and thus become a resident population.

(5) That bunchy top is latent in a considerable proportion of Fiji banana stock and that the shock of soaking is apt to lead to its development.

(6) That in the absence of borer leaf spot shows little tendency to spread, but that it is secondary, following on unhealthy conditions such as borer, bunchy or wet feet.

(7) In the absence of borer, despite leaf spot, fruit ripened normally when cut.

Further investigation into the last three are very necessary.

Note, 15/7/32.—The first ratoon bunches in the two areas are now beginning to appear. The treated and trapped block has not only gained ten weeks over the untreated area in throwing its first ratoon, but the two first bunches to appear are 11 rising 12 hands and 12 rising 13 hands as compared to 10 hands on the check area. Whilst this is an indication of the value of the treatment it is not an exact measure as the pruning of the plants cannot be identical.

ENTOMOLOGICAL DIVISION.

By H. W. Simmonds F.E.S., Government Entomologist.

SUMMARY OF WORK, JANUARY–JUNE, 1932.

Bananas.—Borer investigation (*Cosmopolites sordidus*).—Twelve months' work in the Suva experimental plot was completed April 9th and a report was prepared. Trapping and daily records for individual plants, together with sex records, is being continued. Valuable facts are being secured.

A second banana borer investigation plot has been established at Nasinu and this is making good growth. Work on similar lines, but on a larger scale, is also being commenced at Navuso.

Scab Moth (*Nacoleia octasema*).—Experiments have been carried out conjointly with the Government Chemist with a view to destroying the eggs of this insect. Considerable success has been attained in the laboratory, field tests have, however, not as yet been carried out, except in a very minor way.

An egg parasite has been discovered, giving the low parasitism at Navuso of 1 to 2 per cent. only. This is being investigated in the laboratory.

Fruit Flies (*Dacus passifloræ* and *D. xanthodes*).—Attempts have been made to trap these pests, using a bait evolved in Queensland. Considerable success has been achieved, the percentage of females captured reaching nearly 90 per cent. of the total captures at Nasinu, viz., 851 females to 92 males in seven weeks from six traps. In Suva similar results on a smaller scale were attained.

House flies.—It has been found that the dung-burying beetle *Copris incertus* is well established and that a *Spalanyia* (as yet undetermined) is destroying over 50 per cent. of the pupæ of these pests in the field.

Weeds.—Clidemia hirta.—Colonies of thrips have been sent to Beqa, Wainibuka (5), Ovalau, Ba, Navua and Kadavu (2). Ovservations have been made upon the progress of the insect at Lami, Suva Point, Tamavua 5 miles, Sawani and Nasinu. The results are very satisfactory.

Lantana.—Observations have been made on the work of the lantana bug, which is not giving very encouraging results.

Stachytarpheta indica.—Plants of this weed were raised from seed to test time of flowering and length of flowering period.

Copra Bug.—Experiments in trapping this beetle were not very encouraging.

Laboratory.—The bulk of the cases required for the Suva Agricultural Show have been prepared. Miss McHugh has also prepared drawings for the Ottawa and Auckland Exhibitions.

Library.—This has been re-organised and re-arranged.

General.—The Entomologist spent several days assisting in examining oranges for export.

The Laboratory Assistant, Miss McHugh, was detailed for the general office for a period of approximately three months during the absence of one of the officers from the Colony.

NOXIOUS WEEDS AND THEIR CONTROL IN FIJI.

(Continued.)

By H. W. Simmonds, F.E.S., Government Entomologist.

BIOLOGICAL CONTROL OF CLIDEMIA HIRTA.*

DISTRIBUTION AND SPREAD IN FIJI—PERIOD MARCH, 1930, TO DECEMBER, 1931.

A report on my mission to Trinidad to obtain the thrips *Liothrips urichi* for the attempted control of *Clidemia hirta* in Fiji was published as Council Paper No. 28 of 1930. A strong colony of approximately 20,000 individuals of this thrips was landed in Suva in March, 1930, and of these some 3,500 were immediately released, being distributed in colonies at Lami, Nasinu, and two at Tailevu.

2. After releasing these colonies I proceeded on leave, further liberations being made by Mr. T. H. C. Taylor, the Coconut Entomologist, until my return on 29th January, 1931.

3. During this intervening period colonies were released as follows:—

April.—Nadarivatu, Waimanu, Salia Levu (Taveuni), Ura (Taveuni), and Mua (Taveuni).

May.——Tailevu (2 colonies), Navua (2 colonies), Nasinu, Ovalau (3 colonies).

June.—Navuso, Navua, Sigatoka, Rabi and Waidina.

July.—Tailevu and Sigatoka.

August.—Tailevu and Savusavu (3 colonies).

It will thus be seen that by the end of August, 1930, colonies had been well distributed throughout all the seriously affected areas of Fiji.

4. *Progress of the Insect.*—The first observations made after my return in January, 1931, were most disappointing. The intervening nine months since the release of the thrips had been exceptionally dry and this had proved as unfavourable to the insect as extreme wet; and at Lami, ten months after the colony had been put out, only about 200 yards of very light infestation from the point of liberation could be observed.

5. At Nasinu, similar conditions prevailed, with slight spread and very small numbers.

6. By April the Lami colony was found to have extended to about 400 yards and a visit to Taveuni in May showed that one of the Mua colonies was established and had also spread about 400 yards. Just prior to this Mr. Lever, Entomologist to the British Solomon Islands Protectorate had made a tour of Taveuni and was unable to detect the presence of any of the other colonies.

7. As it was now over a year since these colonies had been liberated and the progress made had been trifling whilst the numbers also remained negligible, much disappointment was felt regarding any benefits likely to be derived from the introduction. June, however, saw a decided improvement manifesting itself. The Nasinu colony began to increase, whilst at Lami 50 or 60 acres were found to be affected. From then onwards the progress of this colony was most rapid and encouraging. By September it had travelled four miles, the infestation being heavy at many places. On 12th November it was found to have crossed the two miles of bush and reached the Visari River, being present in numbers. On December 2nd search was made beyond this river and it was found to have reached the foothills of the Wainiboro watershed, being heavy at the Visari and thinning out as the valley was crossed, a distance of seven or eight miles from point of liberation. At the same time an inspection of the Suva district showed that spreading outwards from the Agricultural Department offices, it had linked up with the Lami colony and extended against the wind as far as the Golf Links, a total linear mileage of perhaps 14 miles. Later, on December 12th, it was discovered five miles along the Colo-i-Suva Road.

8. *Progress on Taveuni.*—On Taveuni the Mua colony was found to be established in April, 1931, but had not spread more than 400 yards when inspected in May. It was not until November that the colonies at Ura, Vuna and Salia Levu were found to be established. By that time, however, a large area was affected and the density of the infection was decidedly heavy. Owing to the slowness of the insect in showing up, five additional colonies were forwarded during 1931 to Taveuni.

9. *On Vanualevu.*—One colony at Savusavu was found to be well established in July, 1931, and excellent reports were received regarding the others. In October, Mr. McGregor of Wainunu reported excellent work being done by the insect on the coconut estate under his management and that gentleman was good enough to distribute a number of colonies from his estate around the district. A colony was also sent from Suva to Natewa Bay in December.

10. *On Ovalau.*—No reports have been received from Ovalau and no opportunity of inspecting has arisen. Two more strong colonies have, however, been despatched during the year to that island.

11. *Other districts of Vitilevu.*—At Nasinu the spread of the insect has, as yet, not been so satisfactory. It is all over the Experimental Station and has reached the road, but does not seem to have travelled along the road to any extent.

12. In September a strong colony was sent to Waidoi to help bridge the Lami–Navua gap, and in December another one was sent to the upper Rewa at Vunidawa. Splendid reports have been received of the progress of the insect at Tailevu but, as yet, no opportunity of inspection has occurred since these reports were received.

13. At Sawani and Navuso also the insect has taken firm hold, the owners of the land reporting excellent results. There has been no opportunity of a thorough inspection, but on December 20th, along the Sawani Road, the work of the insect was plainly visible but not really heavy.

14. Of great interest is the fact that in December the insect was found to have jumped over a mile of sea (or mangrove swamp against the wind) and to be well established on Cave Island. It also had to cross two miles of jungle to reach the Visari River and in travelling west from Suva had crossed a mile of mangrove.

15. These successes show considerable powers of distribution for so frail an insect, and an ability to cross unsuitable areas that was quite unexpected, so that the next twelve months should see most of the colonies linked up.

16. *Future value of Insect.*—It is still difficult to assess the future value of the insect which entirely depends upon the density of its population upon any given area. That density is still rapidly increasing and until that increase ceases and an equilibrium is struck the potential value of the insect is still an unknown but increasingly hopeful quantity.

17. In Trinidad its numbers and effect are far more marked in the dry than in the wet seasons, whilst it does not thrive in certain wet districts. All thrips are apparently sensitive to extremes of wetness or dryness and this is no exception. The extremely dry season following its introduction into Fiji markedly inhibited its early increase, whilst it may suffer further setbacks when we get long spells of heavy rain.

18. In Trinidad the thrips does not seem to thrive in considerable shade and in Fiji a similar dislike of dense shade seems to be present. With greater density of population it may, however, crowd into the jungle to a greater extent than in its original home.

19. The absence of an insect from certain situations does not necessarily mean that it will not thrive in such situations elsewhere, but may only indicate the presence of some natural enemy holding it in check. *Liothrips* was found to have many and powerful enemies in Trinidad. These were carefully eliminated when it was imported and the gratifying success of the importation, which is undoubtedly exercising far more pressure upon the plant in Fiji than it did in Trinidad, must largely be due to the screening out of these enemies.

20. *Future work in Fiji.*—Planters can largely assist the thrips in its good work by cutting down the heavy *Clidemia.*—The new growth which then appears is ideal for the insect, leading to its rapid increase and preventing further growth of the plant.

21. *Seeding of Clidemia.*—One essential point is " will the thrips prevent the seeding of *Clidemia hirta* ?" The answer to this question entirely depends upon the density of the insect population. It has undoubtedly reduced seeding considerably at certain places, but unless it enters the jungle there will in any case still be a quantity of seed produced in such situations.

Summary.—Up to February, 1931, the insect had made little progress, probably owing to the exceptionally dry conditions towards the end of 1930. With more favourable weather it made rapid progress throughout the whole year of 1931, showing a surprising ability to jump considerable distances across water or jungle. During the last nine months of 1931 it colonised, in many parts heavily, six or seven miles down wind and also made some progress in the opposite direction. Whilst it is of course impossible to forecast its full potential value, there is every indication that it is going to be of very considerable assistance to the grazier and planter in this country.

* Published as Council Paper No. 4 of 1932 and laid on the Table at Legislative Council on 16th February, 1932.

BIOLOGICAL CONTROL—PROGRESS REPORT.

By H. W. Simmonds, F.E.S., Government Entomologist.

LANTANA CROCEA AND CLIDEMIA HIRTA.

Inspections were:—Lami, 7 miles, 25th April, 1932 ; Circular Road, 26th ; Tamavua, 5 miles, 27th; Sawani, 30th.

After a month of very heavy rains inspection of noxious weed control by biological means was made in the Suva district on the above sections.

1. *Lantana crocea.*—The Lantana bug, *Teleonemia lantanæ*, is a native of Mexico but damage apparently by closely allied forms was observed in the West Indies as a somewhat uncommon condition. The bug does not seem to thrive under wet conditions and during the past year has been very disappointing, almost disappearing from many localities in which it had given promise of being a useful help to the planter. At the present moment it shows signs of increasing and several areas of heavy attack were observed on the road from the cemetery to Tamavua and the presence of the insect could be noticed at a number of points on the Colo-i-Suva road. The bug has met a most powerful enemy in Fiji in another bug, *Germalus pacificus*, which is probably more important than the wetter climate in holding it in check.

2. *Clidemia hirta.*—Generally speaking, the intensity of the infestation of the above weed by *Liothrips urichi* showed an apparent reduction, as would be expected after the heavy rains of the past four weeks. In consequence, many plants in the Lami district showed signs of renewed growth; all of these, however, were found to be attacked.

3. In the Circular Road area, the affected portion, which was heavily attacked, had all been cut down by the owner. It will be interesting to see if the plant is again able to struggle up.

4. Between Tamavua Village and the five mile is an immense area of *Clidemia*, which was only found to be infected by the thrips on December 12th last, so that it was not expected, in view of the wet season, that infestation would, as yet, be very severe. Inspection showed that the insect was widely and abundantly distributed, although there were many patches which had as yet escaped. In a few places the intensity was severe and grasses were observed to be spreading over the weed.

5. *Sawani.*—At Sawani the incidence of the thrips was not as heavy as hoped for. This also is no doubt due to some extent to the recent rains. The insect is now fully linked up with Suva *via* the New Road. Along the hedges it was interesting to see how *Mimosa* was choking out the *Clidemia* and examination of many clumps of the former by the roadside showed the presence of a core of the latter. Indications were that the attacks of the thrips checked the growth of the *Clidemia* allowing other plants to overgrow it. The recent rains have in some cases started the plant into new growth, but examinations showed that where overgrowing had taken place there were indications in almost all cases of thrips attack and dieback due either to this or some other agency. Mealy bug, mites and aphis were also present and might of course have produced a similar effect. In addition to these instances it has been observed that at the old hospital, the Cemetery, Tamavua Road and Lami, a number of known patches of the plant have entirely disappeared. These have been brought about by—

(*a*) attacks by *Liothrips* as above, checking the growth of the weed, so that para grass, sensitive, mile-a-minute and other grasses and weeds overtopped and smothered it;

(*b*) in other places, where the roadside had been cut back, the thrips had held the new growth of the weed back until the grasses and such weeds as blue rat tail had replaced it.

Examination of steep red clay banks showed the same old stand of young seedlings as in former years. These small seedlings do not seem to suffer much from the insect until perhaps 4 in. or 6 in. in height, when they are generally attacked. Most encouraging was considerable penetration by the thrips into the jungle at Lami, where there is heavy *Clidemia* growing in somewhat open jungle.

6. The behaviour of the insect at five miles, Tamavua, will be watched with much interest during the next few months. It is not easy to judge the ultimate value of the control which will be obtained. Three patches which had been under observation have been cut down and only two have gone through as yet to their conclusion. In these an altered plant association is being formed. The highly dominant *Clidemia hirta* when attacked by the thrips becomes stunted and failing to make growth, is soon overrun by such rapidly growing plants as Para grass, Mimosa, and *Micania scandens*, leading to its eventual death. Unfortunately, a number of weeds also invade the newly-formed territory, of which *Stachytarpheta indica* in meadow land and *Solanum torvum* by roadsides are the worst. It is hoped to prepare another report some time in July.

Note.—Since the above was written further observations have been made on the Coli-i-Suva road where the thrips is rapidly increasing and in the jungle, just behind Nasinu, where it was observed (12/6/32) that the insect was attacking curse heavily in old charcoal clearings half a mile or more into the forest on both sides. It had also (17/6/32) reached Suva Point, travelling 3½ miles against the wind. At the Suva Samoan Church the curse was being destroyed by the thrips attack followed by *Thumbergia* climbing over the stunted plants (17/6/32). It is only in such areas as this last, where the plant can be observed frequently that observations as to the ultimate effect of the insect can be made.

THE POSSIBILITIES OF CONTROLLING RATS ON COCONUT ESTATES IN FIJI.

By T. H. C. Taylor, M.Sc., Entomologist.

[Mr. Taylor summaries below the main results of inquiries he made on behalf of the Coconut Committee while on leave in England during 1931. Those persons who desire further information on points raised in this report should apply to the Department of Agriculture. The Memorandum "Red Squill as a Rat Poison" and the suggestion made by Mr. Read in the book *Rats and Mice as Enemies of Mankind* are not published.—Editor.]

During my leave in England I discussed the rat situation in Fiji with a number of authorities, notably Mr. E. C. Read of the Ministry of Agriculture and Fisheries, and Mr. M. A. C. Hinton who is Deputy Keeper in the Department of Zoology at the British Museum. These two gentlemen in particular have kindly given me much information which, though it is by no means directly applicable to the problem in Fiji, may be useful in indicating the kind of experiments which will have to be made in Fiji before we can hope for any success in our efforts to combat rats in that country. Unfortunately, the problem of rat destruction in Fiji is infinitely more difficult than in European countries, and most of the methods employed in Europe would be quite impracticable on coconut estates in Fiji. Three main lines of

inquiry, listed below, suggested themselves, and I will deal with each one separately:—

I. Biological methods—
 (*a*) virus diseases and other natural enemies;
 (*b*) the Rodier method.
II. Trapping.
III. Chemical methods.

I. Biological Methods.

(*a*) *Virus diseases and other natural enemies.*—I hoped at first that virus diseases might prove the most suitable means of controlling rats in Fiji, but I find on inquiry, and on the advice of both Mr. Read and Mr. Hinton, that there is not the slightest hope of success with them from our point of view. The chief reason for this is that the rats acquire immunity from the disease; but also, in big areas of country such as those with which we are concerned, the spread of the disease is very slow, only a small percentage of the rats is attacked, and the virus preparation rapidly loses its virulence. In certain restricted areas, and in specially favourable conditions, virus diseases have given satisfactory results, but there is no known virus or other disease, nor any other natural enemy, which could be usefully applied to Fiji conditions. I should point out also that although virus preparations are often advertised as being harmless to other animals there is in reality some doubt as to the truth of such statements and further evidence is still required.

(*b*) *The Rodier method.*—This method consists, briefly, in trapping the rats alive, killing all the females caught and liberating the males. It is of great biological interest, but so far as I can see, it is utterly impracticable on a large scale in Fiji. I think, however, that we might be able to apply it in an indirect manner by utilising certain chemical measures (suggested hereafter) which might bring about a predominance of males over females and so result in conditions comparable to those upon which the Rodier method depends for its success. But the biological assumptions involved in this method do not appear to be satisfactorily proved, and I do not think it wise at present to rely much upon it.

II. Trapping.

Trapping obviously is useless in the country in Fiji unless it be found that there is any relationship between the damage done on estates and the proximity of buildings. It is often stated in Fiji that rat damage to nuts is far greater near buildings than in other parts of the estates, but personally I am doubtful on this point. In any case trapping would not affect the rat population of a large estate appreciably except in conjunction with other methods.

III. Chemical Methods.

Although biological methods are very attractive because they involve much less labour and if successful are permanent, I am afraid we must face the fact that no suitable biological methods are available and that the much more laborious chemical methods are our only hope in the earlier stages of the work, if not in the later stages also.

Chemical methods comprise poisoned baits and fumigation. Their use on large estates in Fiji would certainly involve considerable labour and organisation, but they would not be expensive. Their successful use would depend firstly upon a very thorough knowledge of the habits of the rats which live in coconut palms, and at present we have no such knowledge; and secondly upon the close co-operation of the planters. It would, I think, be possible

for the Department of Agriculture to undertake the large amount of preliminary study and experimenting which would be essential before any definite scheme could be found, and I think it would be possible to devise a practicable scheme eventually, but the planters themselves would have to undertake and supervise the application of the scheme to their own estates. Unless it is considered likely that general co-operation of this kind could be expected it would be a waste of time for the Department of Agriculture to undertake the preliminary experiments. I know there are many planters who would be delighted to undertake this work, but their labours would be wasted if their neighbours did not follow their example. The rate of multiplication of rats in the tropics is so great that the thorough destruction of them over a limited area only is of no avail.

If it is decided to attempt chemical meand of control it would first be necessary for one man to devote all his time for a period of several months to a large scale study of the habits of the rats on estates, with a view, in particular, to deciding the following points:—

(1) is the species absolutely definitely determined? I have assumed that it is *Rattus rattus*, which is typically arboreal but which varies its habits greatly according to its degree of association with humans. The other species, *R. norvegicus*, is essentially a ground rat, though its habits vary almost as much as those of *R. rattus*;

(2) what is the normal habitat of the rats which damage coconut estates? We know that they nest in the trees, but do they always nest in the trees or do they nest eslewhere as frequently?* It is also important, in devising control measures, to ascertain whether, as Mr. Read thinks likely, there is any seasonal variation in their habitat; that is to say, whether they come to the ground or enter buildings periodically for nesting, copulating, change of diet, or any other purpose;

(3) what are the alternative foods of the rats which normally attack healthy nuts, or do they feed solely upon the nuts and obtain all the drink they need from them?

(4) are there definite breeding seasons, or rather are the rats more prolific at certain times of the year?;

(5) are the rats in towns the same as those on estates?;

(6) what natural enemies have they in Fiji?

(7) what is the proportion of the sexes in Fiji?

In clearing up these points it is important to remember that it is not sufficient to assume that the habits of the species in Fiji are the same as those recorded for the same species elsewhere. Their habits are so variable that in two countries which are similar in most respects the rats may evolve totally different habits. It is therefore necessary to study their habits afresh in each country.

I think it likely that in the course of an investigation such as that which I have outlined above we might discover some particular habit which we could use to our own ends. What we need is the discovery of some weak point in the rats' defences. We should gain nothing by attempting to poison the rats without correlating our methods very closely with their habits. We might, in fact, do harm, because it has been found in certain cases where the males

* There are many people in Fiji who state the rats that spend the whole of their lives in the trees and never come to the ground at all. There is at present insufficient evidence for such a sweeping statement.

outnumber the females that some poisoned baits attract males more than females, and the consequent equalising of the sexes results in more prolific breeding.

The various chemical methods already employed include some which, though they have been successful in Europe, would be quite impracticable in Fiji. I am sending pamphlets dealing with all measures which could possibly be of any help in Fiji. Gassing, could not, so far as I can see, be of much use except as a supplementary measure in the neighbourhood of buildings, unless it is found that some definite seasonal migration between buildings and trees occurs. Of the various food poisons, squill certainly seems the most hopeful, especially if it can be grown in Fiji. There seems no doubt now that squill, as given to rats, is quite harmless to cattle, pigs, and fowls (*vide* Memorandum " Red Squill as a Rat Poison "), and it certainly seems the most suitable poison for natives to handle. I am inclined to think that Mr. Read's suggestion (*vide Rats and Mice as Enemies of Mankind*, p. 42) *re* the use of squill and milk as a bait is one which merits our attention in Fiji. Coconut milk might be employed, but probably cow's or goat's milk would be preferable because it is usually desirable that the bait should be a variation from the usual diet of the rats. With good organisation, this method should be practicable on a large scale in Fiji, provided that it can be applied at the right times, relative to the rats' habits. The important point is of course, that the milk affords a special attraction for the females, and the baits therefore cause excessive destruction of females. The conditions on which the Rodier method depends are thus indirectly produced, and if Rodier's claims are sound a great reduction in the rat population should follow automatically, without further baiting. I mention this method in particular because we need some basic scheme to begin with, and this seems to me to be the ideal. A study of the rats' habits, however, may show it to be impracticable or may suggest an entirely new method. It is, in any case, impossible to apply the Rodier method in its direct form in Fiji, not the least of the difficulties being simply that it is by no means easy to distinguish the sexes of rats quickly, when one is dealing with hundreds.

I would suggest that after a thorough knowledge of the habits of our Fiji rats has been acquired, it would be well to write to Mr. Pemberton, of the Honolulu Sugar Planters' Association, whom I know well, and put the case before him. He did some excellent work in Hawaii on sugar estates, using mostly barium carbonate baits as far as I remember, and he might have some sound suggestions to give us.

In conclusion, both Mr. Read and Mr. Hinton have assured me that they will be delighted to give us any assistance and advice at any time. The former should be consulted on chemical and mechanical methods, the latter on biological methods. Also, I understand that any of the firms in the " List of Firms who Supply Poisons, &c." will supply sample quantities for experimental purposes.

N.B.—I understand that the Imperial Institute has advocated banding as a control for rats. I have disregarded this method, which I have seen in use in Tahiti, for two reasons. Firstly, it is impossible to dislodge all the young rats from the trees when the bands are put on; secondly, a great deal of supervision is constantly necessary to ensure that the bands are not "bridged" by fallen coconut leaves or branches of other trees. The reduction in the number of rats in the trees is too temporary to be of appreciable value.

VETERINARY NOTES.

TRAUMATIC PERICARDITIS (WIRE IN THE HEART).

By C. R. Turbet, B.V.Sc., Senior Veterinary Officer.

It is annoying enough to have animals die from diseases over which we have little control. It is much more annoying, however, to lose them from a preventable cause. Such a cause of preventable death is the ingestion of foreign bodies such as pieces of wire nails and other miscellaneous iron articles by cattle, leading to a condition known as *Traumatic pericarditis*. This condition is an inflammation of the sac surrounding the heart due to the penetration of one of the before mentioned bodies penetrating and ulcerating its way from the front end of the stomach forward through the diaphragm and into the heart sac, sometimes even penetrating the heart itself. It is a peculiar thing that in cattle, this is the route generally taken by foreign bodies penetrating from the stomach.

An animal affected with this condition almost invariably succumbs. In the history of veterinary surgery some animals have been saved by surgical operation, effecting the removal of the foreign body, but in most cases the condition is a hopeless one.

This disease is preventable, because in almost every case it results from some carelessness on the part of human beings. The following examples are from actual histories of cases. Repairs were being effected to a stay of a wireless mast. The splicing of the steel wire stay was necessary and the loose ends of the splice were snipped off and allowed to fall on to the grass. About a month later a cow which commonly grazed about the wireless mast was affected with *Traumatic pericarditis* and succumbed. The pieces of wire cut off from the splice were recovered from the heart sac. In another case repairs to a telephone wire passing over pasture land were carried out. Loose ends of copper telephone wire, cut off, and allowed to fall in the pasture were taken up by cattle, resulting in the death of two beasts. The wire was recovered on post mortem examination. In the third instance it was customary for the owner to pile packing cases near the " bail-up " where cattle were fed and were accustomed to congregate. Two beasts died on this property as the result of penetration of packing case nails from the stomach.

Ruminating animals do not chew their food on first taking it into their mouth and do not therefore feel foreign bodies as readily as other animals and so expel them. Their feeding is rather rapid, protruding the tongue itself which partially encircles the grass or fodder to be ingested, the incisor teeth on the lower jaw, working with a cross-wise cutting action, cuts off the grass. The tongue then presses the mass into a ball suitable for swallowing and it passes down almost immediately into the stomach. Mastication is conducted during that operation known as chewing the cud. The danger of cattle taking up foreign bodies from pasture is thus evident.

Early symptoms of this condition are not prominent. The animal is first noticed to go off its feed, later on it may become dejected and not move about. Sometimes diarrhœa sets in and the fæces become foul. The animal may have increased thrist. On listening over the region of the heart the action of the heart may be pounding, or a gurgling sound may be heard. Sometimes it is even described as a metallic tinkling. Beneath the chest and along the brisket becomes swollen with dropsical fluid as the disease becomes more pronounced. The animal emits frequent groans of pain There is no hope for an animal in this condition and it should be destroyed.

The disease is more prevalent among cows of small owners confined in paddocks near to human habitation; in other words, the house cow is the one more often affected. Animals grazing over large open areas seldom contract the condition.

The object of this short article is to endeavour to impress upon farmers the dangers to their cows and to urge them to exercise the utmost care when carrying out fencing, not to leave fencing staples or cut ends of wire in the pasture and to avoid by all possible means the access of the cattle to such dangerous material.

TUBERCULOSIS CONTROL IN DAIRY HERDS.

By C. R. Turbet, B.V.Sc., Senior Veterinary Officer.

This subject must be considered from two different view points, firstly, animal health, secondly public health. Veterinary science is directly concerned with the former and indirectly with the latter. Any improvement which might be effected in animal health through the efforts of veterinary science has its ultimate beneficial effect on public health.

One might be asked why special steps should be taken to eradicate tuberculosis and other diseases from dairy herds as opposed to cattle of purely beef herds. The reason is not hard to find. The cow may be likened to a machine which is working under very great pressure and upon whose system great strain is thrown. In nature she produces only sufficient milk to rear her calf and conducts a very leisured life. As a dairy cow, however, not only has she to carry the unborn calf within her body for the greater part of the year, but whilst doing so is also forced to produce unnatural quantities of milk. At the same time, her conditions of life on some dairy farms in Fiji are very hard, being forced as she is, to pass through quagmires four times daily in entering and leaving milking yards and whilst so doing being jostled and horned. The close association with other animals such as occurs in milking herds and in the pasture lays the cow open to contact with a greater concentration of germs than occurs in the conditions of beef cattle raising. This factor, together with her lowered resistance, renders dairy cattle particularly susceptible to tuberculosis and other diseases.

The dairy-bred calf is also raised under conditions which predispose it to the disease. In beef cattle little disease is seen in calves. In dairy cattle on the other hand, such conditions as scours, severe worm infestation, loss of hair, and enlarged abdomen are common. The calves are housed, closely confined, often being soiled with each other's excreta and drinking a composite sample of milk from the whole herd. In the event of tubercle bacilli being shed in the milk by even one cow the bacilli will be distributed through the whole of the milk and as a result when the calves are fed each is liable to receive a small dose of the tubercle bacilli. It will be seen that not only is the dairy calf raised under adverse conditions for development and avoidance of general disease but the risk of infection by tuberculosis bacilli is greatly enhanced. It is to be expected therefore, that tuberculosis unless effectively controlled in dairy herds will continue to be a very great menace to the lives of the animals and a source of considerable and recurring loss to dairy farmers.

As a result of inspections of both beef cattle and dairy stock conducted by officers of the Veterinary Staff in Fiji it is definitely demonstrated that the incidence of tuberculosis is considerably higher amongst dairy stock

than others. A few results of inspections in 1931 and 1932 taken from monthly reports are given:—

Beef cattle.			Dairy cattle.		
No. inspected.	Tubercular.	Per cent.	No. inspected.	Tubercular.	Per cent.
1,139	5	0·43	3,244	24	0·74
3,532	13	0·36	2,988	22	0·73
678	1	0·14	1,600	16	1·0
2,705	7	0·25	1,520	21	1·45
860	2	0·23	1,138	61	5·236
8,914	28	0·31	10,490	144	1·37

These comparisons not only demonstrate the greater incidence of tuberculosis in dairy herds, but also indicate an increased incidence.

Loss to dairy farmers therefore, through decreased milk yield and an annual percentage loss of dairy stock is high. Not only is the loss experienced among cows but owing to the habits of bulls probably a greater percentage of bulls become infected than cows and as a result many valuable bulls have been lost to this Colony through tuberculosis. I might even say that the ultimate end of most of the imported pure-bred dairy bulls is destruction on account of tuberculosis. Efforts towards stock improvement are, therefore, dealt a severe blow. The average percentage of annual losses through mortality due to tuberculosis can be confidently placed at 3 per cent.

The intradermal tuberculin test provides a means which is 99 per cent. efficient for detecting tuberculosis in cattle. By this means with the system properly organised it would be possible to discover all tubercular animals which might then be removed from dairy herds. There is no argument about this. It can be done and without very great cost. Having applied the tuberculin test, however, our trouble commences. The disposal of the reacting animals offers a formidable proposition. To destroy immediately all reactors which would range from 10 per cent. to 50 per cent. among untested dairy herds would strike a crushing blow to the dairy industry. The Government of Fiji certainly could not afford to compensate owners for this loss and I doubt whether any country in the world could stand up to such a loss to be borne at one time. The alternative means of disposal is to destroy those reactors which show clinical signs of the disease in any portion of the body, old cows and cows of low production. Those animals in which no evidence whatsoever of tuberculosis can be found, apart from the evidence of the test might be isolated on farms under the control of private individuals who would be prepared to run the farms under the following conditions:—

> The cattle on these known tuberculosis-infected farms are to be permanently isolated. No new stock except tubercular animals are to to brought in and none of the tubercular animals are to leave the farm. The calves born are to be either removed at once to a non-infected farm and reared on milk from tubercular free cows or the calves are to be isolated on the farm and fed on pasteurised milk. Any cow developing manifest lesions of tuberculosis to be destroyed at once. Butter-fat from these farms might be submitted to factories for the manufacture of butter after pasteurisation. Tubercular-free herds

should be annually retested to detect the occurrence of any odd case of tuberculosis which might occur and act as a source of re-infection to the herd.

This method of control and eradication is no theory. Instituted by the great Veterinarian Bang, it is the method which has been adopted for many years in Norway, Sweden and Denmark with great success.

The value of the tuberculin test as a means of freeing the herd from tuberculosis is already realised by several dairy farmers apart from those supplying milk. These farmers, dismayed by the ravages of the disease in their herds, prefer to have the test done on their own initiative and cut the first loss in favour of future freedom.

In Hawaii and the United States mainland tuberculosis is being attacked with utmost vigour by an universal application of the tuberculin test. The great majority of reactors are destroyed in public abattoirs and any meat passing meat inspection is used for human consumption—a sound and economical means of disposal. All hides and offal are completely utilised. As a result eradication is complete in some States and within sight in others.

In any scheme for eradication of tuberculosis some expense will be incurred and losses sustained, but it must come, sooner or later. For the benefit of all concerned the sooner eradication is attempted the smaller the initial loss. The cost of tuberculosis eradication will be greatly increased with the breeding up of greater herds and larger numbers of infected animals.

SUMMARY OF THE WORK PERFORMED BY THE VETERINARY DIVISION FOR THE HALF YEAR ENDING JUNE 30, 1932.

By C. R. Turbet, B.V.Sc., Senior Veterinary Officer.

Staff.—Messrs. Turbet and Stuchbery were both stationed in Suva and operated from that centre. Mr. Koster, Stock Inspector, was stationed at Lautoka and worked in the districts from Ra to Colo West.

Tick control.—No active measures were taken to eradicate ticks from the tick area; owners, however, were urged to hand-pick their cattle whenever ticks were seen on them. Since Indian owners exercise a close supervision of their cattle there was some practical usefulness in this procedure. All animals leaving the tick area have been inspected and sprayed before leaving. No ticks have been seen since April. Climate and seasonal variation undoubtedly has an influence on the incidence of the tick. At this stage it appears that the tick *Hæmaphysalis bispinosa* will be hardly worth considering as an impairing factor in cattle husbandry.

Tuberculosis.—The chief work of the Headquarters staff was in the tuberculin testing of registered dairy herds supplying milk to Suva. A complete round of testing was completed on 24th June. Among these herds 735 head of cattle were mustered and tested. The percentage of infection found was 11 per cent., as compared with 16·4 per cent. at the end of 1931. The dairies more intimately situated to Suva gave a much lower reaction percentage, viz., 4·4 per cent. In addition to registered dairies, other animals, bringing the total number to 1,127 were tested to the end of June, with 9·8 per cent. reaction.

Stock Inspector, Lautoka.—This officer has been engaged in administering the Stock Improvement Ordinance and Foreign Animals Importation Ordinance in the western districts. In addition he inspects stock for detection of infectious diseases, advises owners in the care of their animals and makes observations on native and Indian agriculture for the information of the

Department. The Stock Inspector has visited each of the following districts several times, working from Lautoka:—Ba, Nadroga, Colo North, Nadi, Colo West.

Animal importations.—No cattle have been imported in the first half year. Importations of other animals are also smaller. The usual system of quarantine was maintained in respect of these importations.

Animal diseases.—Contagious abortion has not been very prominent, there being no virulent new outbreaks. A mortality of pigs was investigated and diagnosed as acute gastro-enteritis of dietetic origin. Other diseases including those of poultry, have not been common.

Laboratory examinations.—Several specimens have been received in the laboratory for examination. Some were submitted to the Government Bacteriologist for his report.

Tours from Headquarters.—The following districts were visited:—Taveuni, Makogai, Levuka, Navua, Tailevu, Lower Rewa, Navuso Dairy and Government Farms and Institutions have also been visited in respect of animal diseases or management.

Native students.—Instruction was continued by Veterinary Officers in subjects relating to animal health and management.

ANIMAL FOODSTUFFS IN FIJI.

By H. M. Stuchbery, B.V.Sc., Government Veterinary Officer.

Although there is in Fiji a wide range of feeding material available for stock, the range of materials used by individual herds is, as a general rule, very limited. Thus, it will be found that practically the sole feeding material in the dairying districts is obtained from pastures, and that the Indian cultivator uses for his working animals, the natural pastures plus cane tops or cut guinea or para grasses.

2. While it is admitted that pasturage is naturally the best and most accessible basis for the rations of most animals in Fiji, it is necessary that such feeding should be supplemented by food materials with a greater nutritive value if the maximum usefulness is to be derived from the animal.

3. We might best compare the relationship of an animal to the foodstuffs it contains as that of a machine to transform the energy value of such food into different forms, whether such energy be ultimately expressed as units of work performed by the animal, or latent energy in butter fat produced, or flesh built up by the animal, or energy used up by the animal in sustaining its own life. The output of energy by an animal will depend on the quality as well as the quantity of foodstuffs supplied to it, just as the output of work by an engine depends on the quality as well as the quantity of fuel used.

4. The principal aim of scientific feeding is to supply the animal with the different food constitutents in the exact proportion that the animal requires for its special purpose. The main organic constitutents of animal foodstuff are protein, carbohydrates and fat, with the addition of inorganic substances such as calcium phosphorus and iron for building up and replacing certain body tissues, plus a certain amount of roughage to add bulk to the food and assist in digestion. The true value of foodstuffs depends largely on two factors, the percentage of organic constitutents in the food and the ratio of protein to carbohydrates and fat. This latter factor is called the nutritive ratio and should lie within certain limits to obtain the best value for feeding purposes. In the case of dairy cattle this ratio should be in the neighbourhood of 1 to 6·5; that is, say, the quantity of carbohydrates and

fat should be 6½ times that of protein. It is only by the judicious mixture of foodstuffs that this ratio can be obtained. The nutritive ratio of para grass is about 1—9·7, that of coconut meal 1—4·4. It will be noticed that the nutritive ratio in the case of para grass is too wide while that of coconut meal too narrow. A judicious mixture of these two foods would bring the nutritive value nearer the required figure.

5. Another factor militating against pasture grasses as a sole diet for stock is the great bulk of these grasses required to supply the animal with sufficient nutriment. In the case of such grasses as para and guinea the bulk of food required by a dairy cow would be in the vicinity of 125 pounds. Again it will be found that the addition of concentrated foods to the diet lessens the bulk of food required to be assimilated.

6. The following table gives the analyses of the more common foodstuffs in Fiji and should allow stock owners to make an estimate of the comparative values of these various food materials:—

	Water.	Ash.	Protein.	Carbohydrate.	Fat.	Nutritive ratio.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
Para grass	74·8	2·2	2·2	20·5	·3	1—9·7
Green maize	85·1	1·1	1·6	7·9	·3	1—5·4
Guinea grass	71·5	2·6	2·2	23·0	·7	1—11·2
Rhodes grass	70·0	2·2	3·6	24·2	·6	1—7·1
Elephant grass	85·3	1·6	1·7	10·6	·9	1—7·4
Cotton seed (crushed and whole)	9·4	4·6	19·5	47·5	19·0	1—4·8
Rice bran (low grade) ..	9·5	11·3	10·9	58·5	9·8	1—7·6
Rice bran (high grade) ..	10·1	9·7	12·1	56·7	11·4	1—6·9
Coconut meal	7·7	5·7	20·4	49·1	17·1	1—4·4
Maize meal	11·3	1·3	9·3	74·3	3·8	1—8·9
Pumpkins	90·9	·5	1·3	5·2	·4	1—4·1
Kumalas	71·1	1·0	1·5	24·7	·4	1—17·1
Sensitive grass plant ..	63·4	1·9	3·91	14·96	·72	1—4·3
Sensitive grass (young shoots)	74·9	1·6	5·5	8·2	·8	1—1·8
Desmodium (Fiji clover) ..	74·6	2·0	2·8	13·8	1·6	1—6·3
Paspalum	76·8	2·2	2·5	11·0	·6	1—5·0

7. The following is an illustration of a balanced ration, where the nutritive ratio of the total daily ration approximates the nutritive ratio required by a dairy cow, and where the total dry matter in the food is sufficient for the animal's daily need. It will be noticed that the total bulk of food is 64 pounds, a much more reasonable quantity than 100 to 125 pounds, which is required when an animal feeds on pasture alone.

BALANCED RATIONS.

	Weight of foodstuff.	Dry matter.	Protein.	Carbohydrate.	Fat.
	lb	lb	lb	lb	lb
Para grass	50	13·5	·4	7·0	·15
Rice bran	6	5·0	·9	2·4	·18
Crushed cotton seed	2	1·8	·36	·4	·36
Molasses	4	3·2	·2	2·4	..
Corn meal	2	1·9	·4	1·4	·1
	24	25·4	2.36	13.6	·79

Nutritive ratio, 1—6.

DIDI RESIN (CANARIUM VITIENSI).

By W. J. Blackie, M.Sc., A.I.C., Government Chemist.

Didi (pronounced dindi) resin is obtained as an exudate from *Canarium vitiensi* and is used as an adulterant of Kauri gum (*Agathis species*).

The sample examined in this investigation was obtained by the Conservator of Forests, Fiji, and consisted of irregular lumps, varying in colour from amber to brownish-black and possessing an agreeable aromatic odour. The sample was fairly hard but this feature varied from piece to peice, some portions being of a gummy consistency.

Several of the harder pieces were selected and ground up for examination. The material powdered easily and was partly soluble in 95 per cent. alcohol, ether, acetic anhydride and more readily soluble in chloroform, petroleum ether, turpentine. It was almost insoluble in water and only slightly soluble in 60 per cent. chloral hydrate. Sugars and gums were absent.

A drop of sulphuric acid added to the material soluble in acetic anhydride gave a red colour immediately changing to deep red and finally brown. The chloroform solution with sulphuric acid gave a yellow colour changing rapidly to red and then to a persistent purplish-red colour

The following solubilities were determined:—

Solvent.	Per cent. soluble.
Petroleum ether	73·4
Alcohol, 95 per cent.	46·0
Water	·9

On extraction with petroleum ether followed by ether and chloroform, the following results were obtained:—

Solvent.	Per cent. soluble.
Petroleum ether	73·4
Followed by ether	8·9
Followed by chloroform	2·6
Insoluble ..	15·1

The insoluble portion consisted chiefly of fibre and other plant material together with a small quantity of non-combustible matter.

The following figures were obtained for the alcohol soluble material:—

Acid value	13·9
Saponification value	28·1
Ester value	14·2

The resin, 120 grams, was dissolved in ether followed by chloroform and the two solutions were examined separately.

Ether soluble portion.—About 20 per cent. of the resin was soluble in ether. This was examined by the method of Tschirch. No free acid was isolated. Steam distillation yielded 5·8 per cent. of a lemon-yellow oil N^{20}_{D} 1·4982 with an odour characteristic of the resin. This polymerised on standing to a semi-solid mass. When further supplies of the resin are available this oil will be examined more fully. The residue from the steam distillation was saponified with alcoholic potash washed with ether, and the acid separated, ·0248 grams were obtained, *i.e.*, ·02 per cent. This quantity was too small for identification. The ether solution of resenes was concentrated and precipitated with alcohol. This yielded a white amorphous powder. This was redissolved in ether and re-precipitated by alcohol, the operation being repeated several times, till melting points were obtained between (182°—185°) C. The material darkened at 180° C. The alcohol soluble portion

on evaporation consisted of a semi-solid yellowish mass, which gave melting points between (80°—90°) C. It was not found possible to purify this material further. The nature and molecular complexity of these resenes was left at this stage for future investigation.

The proportions of resenes and essential oil present in the material were approximately:—

	Weight. Grams.	Per cent. on whole resin.
Essential oil	7	5·8
Alcohol soluble resene	10·6	8·8
Alcohol insoluble resene . ..	6·4	5·3

Chloroform soluble portion.—Sixty-five per cent. of the original material was soluble in chloroform after the ether extraction. Essential oils appeared to have been completely extracted by the preliminary treatment with ether. The chloroform solution was concentrated and precipitated with absolute alcohol. A white amorphous powder was obtained which melted between (183°—185°) C. This appeared to be similar to the product obtained above but was purer. The alcohol soluble product was a yellowish semi-solid mass which could not be obtained in a pure state. The melting points varied considerably and it was considered from the meagre evidence available that it consisted of an alcohol soluble resene or resenes, together with polymerised terpene products. Since this was only a preliminary investigation it was not considered necessary at this stage to determine the nature and molecular complexity of the products.

	Weight. Grams.	Per cent. on whole resin.
Resene precipitated by alcohol ..	25·2	21·0
Resenes not precipitated by alcohol	52·8	44·0

General properties.—The alcohol soluble product was evaporated and the residue disolved in benzene. This solution applied by means of a fine brush to clean copper foil produced a thin elastic film which adhered firmly to the metal and stood up well to bending experiments. It did not appear to be attacked by sulphur-di-oxide or sulphuretted hydrogen, but on immersion in water for three days, moulds developed which destroyed the film. On exposure to high humidity conditions, the film appeared to stand up well.

Selected portions of the resin were dissolved in turpentine and applied by means of a brush to a prepared wood surface. A light-coloured varnish finish, which dried rapidly without leaving a sticky surface, was obtained. A colouring agent would be an advantage here. Owing to shortage of material further tests under outdoor conditions were not tried.

It is proposed in a future investigation to study the properties of these resenes more fully.

Summary.—(1) A preliminary investigation of the resinous exudate from *Canarium vitiensi* has resulted in the isolation of a resene m.p. 183°—185° C., soluble in ether and chloroform, insoluble in alcohol. This resene forms at least 26·5 per cent. of the resin.

(2) Other alcohol soluble resenes are present amounting to 55 per cent. of the resin.

(3) An essential oil amounting to 5·8 per cent. was also demonstrated.

(4) A colour reaction for the identification of this resin has been described.

(5) It would appear, from the evidence available, to have possibilities as a metallic lacquer.

I am indebted to the Conservator of Forests, Fiji, who collected the sample and submitted it for examination.

DERRIS ULIGINOSA.

By W. J. Blackie, M.Sc., A.I.C., Government Chemist.

A determination has been made of the ethereal extract and rotenone content of the local Derris species which occurs in the tiri swamps. It has a local reputation as a fish stunning agent but the natives prefer the imported *Derris elliptica* when it can be obtained. The Conservator of Forests informs me that there is no great quantity of this material available, and that its cultivation would be difficult.

2. For fishing purposes the natives use the crushed up stems which they throw upon the water or drag about in the water, when it is stated that the fish come up to the surface in a stupified condition. They are then easily secured. I am informed that the operation is not always successful with the local Derris species and that a larger quantity of the crushed up stems is necessary than with the imported variety.

3. Since the roots are used in Malaya for the same purpose, I considered it desirable to examine both the climbing stems and the roots for what might be called their " derrid content."

4. In order to obtain finely divided material the following method was adopted:—

The material was cut up into smaller and smaller pieces which were then allowed to partially dry. The partially dried material was then cut up as finely as possible by means of a knife and then by successively pounding in an iron mortar, sieving, air-drying the residue, and repounding and sieving, &c., all the material used for the analysis was made to pass through a sieve of 1 mm. mesh. These operations were very tedious and a considerable saving in time would have been effected if a laboratory mill had been available It was found impossible to obtain a finer division with the means at our disposal owing to the resistent nature of the fibre.

5. The extraction was carried out in the usual manner. It was found that final traces were not removed under 36 hours, but that the bulk of the derrid passed over in about 18 hours. Results:—

Sample.	Moisture.	Ether Extract. Per cent. air-dried material.	Ether Extract. Per cent. of substance.
B—Root	12·6	2·2	2·5
Stem	11·9	1·8	2·4
B—Ground once, coarse ..	9·1	11·1	12·2
Ground twice, fine ..	8·4	11·7	12·8
Ground thrice, fine ..	8·5	12·05	13·2

In the above table A is the results obtained in this investigation. For comparison, some results with *Derris elliptica* obtained by the Chemical Department of the Colonial Institute of the Netherlands, Amsterdam, " Contribution No. 26," quoted by the *Malayan Agricultural Journal* (Vol. XIX, No. 2, 1931, p. 8) are included at B.

6. It would thus appear from the results that the "derrid" content of *elliptica* is at least six times as great as that of *uliginosa*.

7. The rotenone content was determined by the method employed in the Insecticide Division Laboratories of the Bureau of Chemistry and Soils, United States Department of Agriculture, Washington, D.C. The continuous extraction of 100 grams of bulky organic material by means of ether under tropical conditions is an expensive process and it was found necessary to design apparatus for the purpose. Two types were tried with equal success

but one type in simplicity of design is much superior to the other. The structure of this apparatus will form the subject of a separate report. Results:—

Sample.	Per cent. moisture.	Rotenone content. Per cent. air-dried material.	Per cent. of dried substance.
Composite sample of stem root	12·2	0·30	0·34

8. Derris root varies widely in its rotenone content. Samples have been reported containing only a few tenths per cent., but the best commercial samples contain between 4 and 5 per cent. rotenone content. It would therefore appear that *Derris uliginosa* has no very great commercial possibilities. However, it is to be understood that a seasonal variation in rotenone content is probable and that the 0·30 per cent. figure here quoted may not give a true index of its value. It is a significant fact that the natives prefer *elliptica*. The insecticidal value of the material should be tried under controlled biological conditions. Such a solution can easily be made by grinding up the stems in water, since rotenone is very soluble in this medium.

MISCELLANEOUS NOTES.

BLUE RAT TAIL (*Stachytarpheta jamaicensis*, Vahl.).

A SPECIMEN of the above common Fijian weed has been forwarded to Kew for identification and has there been identified as *Stachytarpheta jamaicensis*, Vahl., and not *S. indica*, L., under which name it was formerly known in this country. It has also been referred to in the *Agricultural Journal* as *S. dichotoma*, Vahl., which may be a synonym for *S. indica*, L. *S. jamaicensis*, Vahl., is the species present in Trinidad and now being investigated on behalf of this country.

EXTRACT OF LETTER FROM A FIRM OF FRUIT IMPORTERS, AUCKLAND.

Citrus fruits.—I think I wrote you earlier but I would again mention the fact that the trouble your Department took in connection with oranges and mandarins has resulted in buyers having a very high opinion of the quality and grade of Fiji fruit this season, and if the same care is taken next year we will certainly have a market for both these lines.—7th July, 1932.

PREPARATION OF BANANA FIGS.

By W. J. BLACKIE, M.Sc., A.I.C., Government Chemist.

I.—SUNDRYING.

IN our research scheme for the year it was decided to include the investigation of the methods of preparation of subsidiary banana products. The following report deals with the preparation of banana figs by sun-drying.

2. Some work had already been performed by a former Government Chemist, an account of which occurs in *Agricultural Circular* No. 5, Vol. 2, 1921. Very little information with regard to the nature of the product is given, but it is stated that it would be necessary to dry artificially for commercial purposes in order to be independent of weather.

3. In the following table the composition of the banana and the banana fig is given:—

	Banana—Average composition. Per cent.	Banana figs. Per cent.
Moisture	75·3	29·2
Protein	1·3	5·3
Ether Extract ..	0·6	2·3
Carbohydrates ..	22·0	57·9
Ash	0·8	5·3

4. The figures for the banana fig are taken from *Bulletin* No. 6, *Hawaii Agricultural Gazette.* It is therefore apparent that the moisture content of the fruit must be reduced from 75 per cent. to 29 per cent. with a consequent increase of carbohydrate (principally sucrose) from 22·0 per cent. to 58 per cent. In order to limit the development of moulds and bacteria on such a rich medium as the banana during drying it is essential, as pointed out by Wright (*Agr. Cir.* No. 5, Vol, 2, 1921) to dry the material rapidly. With a sugar concentration of 58 per cent. there is less liability to mould and bacterial attack. To effect this reduction in moisture content rapidly by drying in the sun is not always possible under the high humidity condition ruling in the wet zone and during the wet season. These conditions are accentuated in unseasonable weather such as we have experienced this winter in Suva.

5. Having obtained a market it is necessary in order to retain that market and command fair prices to produce a uniform quality article attractively wrapped and with lasting properties. From the point of view of sun-drying, with Fijian fruit, our difficulties can be summarised thus:—

(1) high humidity conditions ruling in the wet zone for the greater part of the year, and thus—
(2) liability to fungal and bacterial attack;
(3) insect attack during drying;
(4) poor quality of fruit as a result of the condition resulting in immature ripening;
(5) type of fruit used, *i.e.*, Cavendish, Gros Michel or Veimama.

6. If the humidity, that is, the amount of water vapour present in the atmosphere is high, the rate of evaporation is reduced. For a given sun temperature the rate of drying depends directly on the amount of moisture present in the atmosphere in contact with the drying material. If the air is still and highly charged with water vapour, drying is reduced to a minimum and partially dried material may even absorb a certain amount of moisture. Under such conditions moulds and bacteria establish themselves and rapidly develop and a black unsightly product results. Drying is much faster even under these conditions provided a gentle breeze is blowing, nevertheless, the product is not attractive. During our experiments the highest sun temperature registered in the sun was 113° F. and the lowest relative humidity 50 per cent. Under these conditions the fruit took at least five days to dry out and darkened products, which became unsightly after a few weeks' storage, were obtained. Several experiments at a temperature of 90° F. and relative humidities up to 90 per cent. showed that the preparation of banana figs in this manner would be commercially unsound.

7. Unless the fruit is protected during drying, insects feed on the material and many of them oviposit. A moth, in particular, lays its eggs on the drying material and these hatch out during storage and the grub, besides spoiling the appearance of the fig, pierces the wrapping. The stored material must also be protected from cockroaches and similar insect pests. Such material would run the risk of being condemned by Public Health Authorities.

8. The selection of fully matured ripe fruits is an important matter, rendered difficult under our conditions, owing to the early breakdown as a result of extensive cercospora damage. In our earlier experiments badly infected fruit from Navuso (Veimama and Cavendish) was used. On ripening the fruit was found to possess a soft seeded centre with soft brown patches extending into the firmer surrounding flesh. On cutting with a stainless steel knife these soft patches darkened rapidly and on drying the central portion and soft patches were much darker than the other portions of the material. This will be discussed more fully under sulphuring.

9. Slightly different results in regard to colour, aroma and uniformity of the finished product are obtained from the dried figs prepared from the different varieties. These varietal peculiarities are accentuated in the treated products to be described. Considering the three varieties the Gros Michel is much superior in colour and uniformity, but the Cavendish is markedly superior in aroma and taste. It would thus appear necessary to pack the three varieties separately. Generally, the colour deepens on keeping, but more so with the Cavendish and Veimama.

EXPERIMENTAL WORK.

10. During the experimental work the following points were considered:—

(1) selection and preparation of fruit for sun-drying;
(2) drying under sheltered conditions without further treatment;
(3) drying under sheltered conditions after treatment with sulphur dioxide gas;
(4) treatment with $S.O._2$ produced by burning sulphur in a special chamber under sheltered conditions with protection from insect attack;
(5) packing methods.

11.—(1) It was pointed out above that the selection of fruit for sundrying was rendered difficult, due to the condition resulting from Cercospora damage. Peculiarly enough, our treatment with sulphur dioxide gas improved such fruit so that the finished product was little different from normal fruit. This is an important point since much of the reject fruit can be utilised for the production of figs. In preparing the fruit it is cut into halves or thirds, depending on its thickness, slabs about half an inch in thickness being preferable. A stainless steel or bamboo knife is preferred, since the ordinary steel is attacked by tannic acid with the production of iron tannates which give a superficial brownish black colour to the fruit. Fruit which has just ripened is more satisfactory than over-ripened material from the point of view of the more rapid darkening of the latter, and also the firmer nature of the former permits the material to be turned without breaking or sticking. Moreover, the sulphur dioxide treatment is unsatisfactory with over-ripe bananas, a pulpy mass being usually obtained. We find that attention should be given to the following points:—

(*a*) the fruit should be firm, fully matured and just ripe;
(*b*) badly diseased or over-ripe fruit should be discarded;
(*c*) the fruit should be cut with a stainless steel or bamboo knife.

12.—(2) Reference was made in the introduction to the difficulties of sundrying bananas under the conditions normally ruling in Fiji. Our experiments were conducted in the Departmental grounds, Suva, and our experience is therefore limited. No doubt there are places throughout the Group where bananas could be dried more satisfactorily than in Suva, nevertheless I doubt whether such operations could be considered commercially sound. A sample prepared in Taveuni and forwarded to the laboratory for examination was very unattractive, having a brownish black colour and a mouldy

appearance. Fruit chosen and prepared as described in (1) was dried in the sun. The sun temperature varied from 90° to 113° F. and the relative humidity from 50 to 90 per cent. The best products were obtained with a sun temperature of over 90° F. and relative humidity in the neighbourhood of 50 per cent. Under these conditions the normal drying period was five days. The product, however, was much darker than the treated material to be described and became darker still on keeping. If wet weather occurred when the material was partially dry and continued for a day or so, the material, as a rule, although protected during the wet period rapidly succumbed to moulds and bacteria, the spores of which had established themselves during the arrested drying period. Without going into too much detail our experiments showed for the Suva area that drying under the conditions described gave an unattractive dark product, and it was quite evident that preparation of banana figs in this manner would be commercially unsound.

13.—(3) As a result of the difficulties experienced in preparing wholesome figs by the normal method, *i.e.*, without treatment, it was considered that if the fruit could be treated with some harmless chemical in sufficient concentration to kill all spores alighting on it during the drying period that the drying time could be prolonged sufficiently to ensure the elimination of the water without injury to colour, taste or general appearance. It is usual in countries such as California to treat fruit before drying by the fumes of burning sulphur in order to obtain uniformity of product. Such methods had not been adopted with bananas to our knowledge and from analogy with other dried fruits it was thought that a light sulphuring might be advantageous. We found, however, that special conditions were required with the banana owing to its very rapid absorption of $S.O._2$ and to the fact that this is held tenaccously for long periods. Moreover, the banana fig would probably be used more as a sweet-meat and thus escape cooking, which helps to remove most of the $S.O._2$ retained in other dried fruits. In our preliminary experiments heavy concentrations of gas up to 25 per cent. of the volume of the container were used. The bananas prepared as described in (1) were placed on the porcelain tray of a vacuum desiccator and the air pumped out to a suitable pressure, normal pressure being restored by $S.O._2$ from a gas cylinder. The gas was left in contact with the fruit for periods of one to four hours. Several experiments were tried as controls against the sundried sulphured material and observations were made on (1) vacuum oven drying at temperature of 140 to 160° F. with a vacuum of three inches; (2) vacuum drying in a desiccator at room temperature using a vacuum of 2 mm.; (3) drying in an air-oven at 100°C. These experiments will be quoted in detail in a communication dealing with artificial drying. It was found generally that the sundried material was superior.

14. *Experiment No.* 1.—Banana slabs and halves were used. Concentration of sulphur dioxide 25 per cent. In two hours the material had assumed a yellowish creamy colour. Pulping, which had been noted, using higher concentrations of gas was not apparent, but the material was slightly soft. A very pleasing feature was the uniform colour. The material was placed in the sun to dry with an untreated control. Another portion was allowed to dry in a vacuum desiccator over calcium chloride at room temperature assisted by a vacuum of 2 mm. The sun-dried treated material dried to a nice creamy colour with a good flavour, but contained a little too much $S.O._2$. The original form had been destroyed by the excess $S.O._2$ in the preliminary treatment. The untreated bananas blackened and became unsightly. The vacuum-dried material had a good colour but contained in the same time

excessive moisture and $S.O._2$. The weather was unfavourable, sun temperature about 90°, humidity over 80 per cent. Drying time, six days.

15. *Experiment No.* 2.—Cavendish bananas were cut lengthwise into two pieces and treated with $S.O._2$ as before (concentration about 20 per cent.). A portion was dried in the sun, at first on wooden gratings until surface moisture had been removed and then flat down on a wooden table. At irregular intervals during the drying period, three days, the material was turned. In spite of the fact that the material remained out in the rain on the second night a very good product was obtained having a dark creamish colour. A control dried in the vacuum oven was much inferior in appearance to the sun-dried material. Sun temperature 90 to 100° F., humidity 60 to 90 per cent.

16. *Experiment No.* 3.—Bananas were cut lenghtwise and immersed for five minutes in a 1·6 per cent. solution of sulphur dioxide in water. The material was sun-dried as before. The sun temperature was low, about 84° F. and the humidity varied from 75 per cent. to 70 per cent. during drying which took over four days and the product was satisfactory, but not nearly so pleasant in appearance as the sulphured product.

17. *Experiment No.* 4.—Bananas prepared as above immersed for five minutes in a 3 per cent. solution $Na_2 S.O._3$ and sun-dried. Sun temperature about 90° F. relative humidity 71 per cent., The product was much inferior to the sulphured and about equal to the normal control.

18. It was now decided to try various concentrations of $S.O._2$ varying from 2 per cent. to 10 per cent.

19. *Experiment No.* 5.—Gros Michel bananas were prepared in the usual manner. They showed signs of cercospora attack. The fruits were cut longitudinally in half and left over night in the vacuum desiccator in contact with air containing 2 per cent. of $S.O._2$. The material was good but did not have the usual creamy yellow colour characteristic of the Gros Michel prepared by our method. Drying took about five days (absence of breeze), the sun temperature ranging from 90° to 95° F. and the relative humidity from 57 per cent. to 49 per cent.

20. *Experiment No.* 6.—As above, using 4 per cent., 6 per cent., 8 per cent. and 10 per cent. $S.O._2$. In the case of 4 per cent., 6 per cent. and 10 per cent. using Gros Michel fruit good products were obtained, the 10 per cent. being slightly better than the 6 per cent. and the latter better than the 4 per cent. In the case of the 8 per cent., Veimama fruit from Navuso badly attacked with Cercospora was used. A very inferior product was obtained, the fruit rotting before drying was complete. Apparently an 8 per cent. concentration of $S.O._2$ was not sufficient to arrest this advanced condition. Sun temperatures and humidity conditions were similar to those in Experiment No. 5.

21.—(4) Further experiments were carried out on a semi-commercial scale. Fruit prepared as described was sulphured in the chamber used for sulphuring copra (Fiji *Agricultural Journal*, Vol. 4, No. 3). Sulphur mixed with coconut husk was burned to $S.O._2$ in an iron tray, and the sulphured material removed and dried on gratings, the whole being covered by mosquito netting.

22. *Experimental No.* 7.—Bananas of the Gros Michel and Veimama varieties were sulphured in the chamber using 1 lb of sulphur. A concentration of about 10 per cent. $S.O._2$ was produced in this manner for the volume of the chamber considered. The material was left in contact with the gas for two hours. A nice looking product was obtained on drying, containing, however, an excess of sulphur dioxide.

23. *Experiment No.* 8.—As above, using ¼ lb sulphur corresponding to 2·5 per cent. $S.O._2$. Gros Michel was used and an excellent product was obtained on sun-drying.

24. *Experiment No.* 9.—Gros Michel bananas treated as above using 2 ounces of sulphur corresponding to 1·75 per cent. of $S.O._2$. An excellent product similar to that of Experiment No. 8 was obtained.

25. The weather conditions during the course of Experiments Nos. 7, 8 and 9 were good, although the sun temperature fell to as low as 80°F. The relative humidity varied between 57 per cent. and 64 per cent. during the drying period.

26. Fruit prepared as in Experiment No. 9 was suitably packed and sent to the Ottawa Exhibition.

27.—(5) The modern food manufacturer realises three guiding factors in the preparation of products for the market: (1) the material must be uniform in composition and the peculiar properties which determine the nature of the product must be evident in similar degree in the whole output—in other words, the product must be a standardised article; (2) the material should be attractively and hygienically wrapped or packed; (3) the labelling as well as conforming with the food laws of the country concerned should be striking and compel the attention of the prospective buyer. We have dealt in the previous portion of the report with (1). I now propose to offer a few suggestions with regard to (2) and (3).

28. In *Agricultural Circular* No. 5, Vol. 2 of 1921, Wright suggested wrapping in biscuit paper or butter paper and on a large scale packing in wooden boxes. This would no doubt be quite satisfactory in the case of the paper, but packing in wooden cases without a covering would be inadequate. There is no doubt that there is an alteration in the material on keeping, the colour tending to become darker. It would appear to me that these changes are influenced by oxygen and that therefore a sealed container or partially sealed wrapping is preferable. We did not experiment with sealed containers but a suggestion offered by the Director of Agriculture with regard to the use of Cellophane wrapping seemed to fulfil the requirements of (2) above.

29. As a result of several trials we suggest the following procedure. The material after drying should be carefully examined and sorted into grades, depending on the variety of the fruit dried. The material is then rolled flat on a table and the ends trimmed with a stainless steel or bamboo knife. Quantities of half or one pound are then neatly wrapped in white Cellophane, the ends of which can be sealed with any suitable glue. We used Gloy with our packages. A thin strip of blue Cellophane fastened symetrically around the package to hide the margin of the original wrapping would supply an attractive finish. Another suggestion would be to use a yellow coloured Cellophane wrapping with a blue finish. Material so wrapped looks very attractive and is certainly hygienic. The packages could then be packed in suitably dressed boxes to hold, say, 12 or 24 lb, or better still in cardboard cartons.

30. With regard to labelling, it would be an easy matter with a suitably coloured and worded cardboard carton to attract attention. It would be advantageous to state that the material was prepared from sound normal Fiji fruit under hygienic conditions. The wording of the boxes and cartons should present no great difficulty carried out along the lines suggested by date packages. It is sufficient for me here to emphasise the necessity of attractive packing and arresting labelling in modern marketing.

Note.—The sun temperatures recorded above were taken with an ordinary thermometer placed on the drying trays.

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